CLAIMS

1. A method of determining a route for transmitting a signal through a network, the method comprising:

obtaining network data, including link type data, spare capacity data, vendor data, and common mileage data;

obtaining demand data, including origination node data, termination node data, and diversity requirement data;

storing the network data and the demand data;

processing the demand data using a shortest path routing method to obtain an initial route;

updating the network data by decreasing the spare capacity data in accordance with the initial route;

computing an initial cost based on the initial route;

updating the network data by increasing the spare capacity data in accordance with deleting the initial route;

re-processing the demand data using a constrained diverse shortest path routing method until a stop criterion is satisfied and obtaining a final route;

computing a final cost based on the final route; and

outputting the final route and the final cost.

2. The method of claim 1, wherein the constrained diverse shortest path routing method minimizes use of optical transponders in obtaining the final route.

3. The method of claim 2, wherein the constrained diverse shortest path routing method minimizes use of optical transponders according to

$$\sum_{k \in K} {n_k}/{\max_k} \leq 1$$

where n_k denotes a cumulative total count of optical transponders along a path $k \in K$, K denotes a set of possible vendor/release combinations and $\max_k$ is a predetermined parameter specified for each $k \in K$.

4. The method of claim 1, wherein the initial cost and the total cost are based on one or more of a diversity cost, a capacity overload cost and a routing cost.

5. The method of claim 4, wherein the initial cost and the final cost are computed as *Total_Cost(R)* as follows:

$$Total\_Cost(R) = Div\_Cost(R) + Overload\_Cost(R) + Routing\_Cost(R).$$

6. The method of claim 5, where *Div_Cost*(*R*) is as follows:

$$Div\_Cost(R) = \alpha_{div\_count} \times Div\_Count(R) + \alpha_{div\_miles} \times Div\_Mileage(R),$$

where *Div_Count(R)* represents a total number of diversity violations, *Div_Mileage(R)* represents a total violation mileage, and α_{div_count} and α_{div_miles} are predetermined parameters that weigh *Div_Count(R)* and *Div_Mileage(R)* respectively.

7. The method of claim 6, wherein *Div_Count(R)* and *Div_Mileage(R)* are as follows:

$$Div\_Count(R) = \frac{1}{2}\sum_{T_i \in T}\sum_{T_j \in D_i} 1_{\{Common\_miles(R_i, R_j) > \max\_allowed\}} \text{ and}$$

$$Div\_Mileage(R) = \frac{1}{2}\sum_{T_i \in T}\sum_{T_j \in D_i} Common\_miles(R_i, R_j),$$

where $Common\_miles(R_i, R_j)$ measures common fiber span mileage of routes R_i and R_j and *max_allowed* is a predetermined parameter that allows flexibility to ignore short fiber span diversity violations.

8. The method of claim 5, wherein *Overload_Cost* is as follows:

$$Overload\_Cost(R) = \alpha_{overload} \times \sum_{e \in E}\sum_{p \in P} \beta_e \max\{0, load(e,p) - cap(e,p)\},$$

wherein

$\alpha_{overload}$ is a predetermined parameter denoting relative importance of capacity violation,

β_e is a predetermined parameter denoting relative importance of a link $e \in E$,

$load(e, p)$ denotes a total load on the link e in a period $p \in P$, and

$cap(e, p)$ denotes a total spare capacity of the link e in the period p.

9. The method of claim 5, wherein *Routing_Cost* is as follows:

$$Routing\_Cost(R) = \alpha_{route} \times \sum_{R_i \in R}\sum_{e \in R_i} Link\_Cost(e)$$

where α_{route} is a predetermined parameter denoting relative importance of *Routing_Cost* in *Total_Cost* and *Link_Cost* is a constant plus link mileage.

10. The method of claim 9, wherein *Link_Cost* is as follows:

$$Link\_Cost(e) = \begin{cases} 1 + \alpha_{route\_miles} \times Mileage(e) \\ : if \ e \ is \ a \ simple \ link \\ \alpha_{proj}(No\_of\_DWDMU\_CrossSections + \alpha_{route\_miles} \times Mileage(e)) \\ : if \ e \ is \ a \ composite \ link \end{cases}$$

where α_{route_miles} is a predetermined parameter denoting relative importance of mileage, *Mileage*(e) is mileage of a link e, α_{proj} is a predetermined parameter denoting a discount value for using an existing project link and *No_of_DWDMU_CrossSections* is a number of dense wavelength division multiplexing unit cross sections.

11. The method of claim 1 wherein the demand data includes project integrity data.

12. A method of determining routes for transmitting signals through a network, the method comprising:

obtaining a plurality of demands T, each demand T_i having diversity requirements D_i;

processing each demand T_i consecutively using a shortest path routing method to obtain a corresponding initial route R_i which satisfy the diversity requirements D_i if network parameters permit;

updating the network parameters based upon the initial routes R;

computing an initial cost solution based on the initial routes R;

re-processing each demand T_i using a constrained diverse shortest path method to obtain a corresponding final route R_i' until a stop criterion is satisfied;

computing a final cost solution based on the final routes R'; and

outputting the final routes R' and the final cost solution.

13. The method of claim 12, wherein the constrained diverse shortest path method includes:

assigning a cost c_e to each of a plurality of links in the network;

determining a shortest route R_i' from an origination node A_i to a termination node Z_i based on link costs c_e;

determining if route R_i' satisfies an optical transponder constraint; and

determining if route R_i' satisfies the diversity requirements.

14. The method of claim 12, wherein the constrained diverse shortest path method includes:

creating an initial partial path *pn* having parameters *node*(*pn*), *cost*(*pn*), *violation_set*(*pn*) and *parent*(*pn*) wherein

node(*pn*) is set equal to A_i,

cost(*pn*) is set equal to zero,

violation_set(*pn*) is set equal to null, and

parent(*pn*) is set equal to null;

storing initial partial path *pn* in memory;

initializing a value *Heap* that indicates whether there is an established pathway to Z_i; and

determining whether the established pathway is compliant with an optical transponder constraint, if *Heap* is equal to null.

15. The method of claim 12, wherein the constrained diverse shortest path method includes:

creating a partial path *pn* having parameters node(*pn*), cost(*pn*), violation_set(*pn*) and parent(*pn*) wherein

node(*pn*) is set equal to a termination node of a previous partial path *pre-pn*,

cost(*pn*) is equal to a current total cost of the partial path *pn*,

violation_set(*pn*) is a collection of violated diversity requirements of the partial path *pn* and

parent(*pn*) is the previous partial path *pre-pn.*

16. The method of claim 12, wherein the constrained diverse shortest path method includes:

selecting a partial path pn_i, having parameters *node*(pn_i), *cost*(pn_i), *violation_set*(pn_i) and *parent*(pn_i) from one or more partial paths, where *cost*(pn_i) is minimal in comparison to costs associated with other partial paths, when a *Heap* value is not equal to null; and

equating partial path pn_i with a route A_i-Z_i if *node*(pn_i) is equal to Z_i.

17. The method of claim 12, wherein the constrained diverse shortest path method includes:

selecting a partial path pn_i, having parameters *node*(pn_i), *cost*(pn_i), *violation_set*(pn_i) and *parent*(pn_i) from one or more partial paths, where *cost*(pn_i) is minimal in comparison to costs associated with other partial paths, when a *Heap* value is not equal to null;

if *node*(pn_i) is not equal to a termination node Z_i, identifying a link adjacent to *node*(pn_i);

creating a new partial path pn_i' from *node*(pn_i) to the identified link;

determining if the new partial path pn_i' satisfies an optical transponder constraint; and

updating the *Heap* value with the new partial path pn_i' if the new partial path pn_i' does satisfy the optical transponder constraint.

18. The method of claim 17 further comprising:

discarding the new partial path pn_i' if the new partial path pn_i' does not satisfy the optical transponder constraint.

19. The method of claim 17, wherein the determining step includes determining whether the cumulative jitter noise along the new partial path pn_i' from an origination node A_i to $node(pn_i')$ plus cumulative jitter noise from $node(pn_i')$ to the termination node Z_i is below a predetermined threshold.

20. A method of determining routes for transmitting signals through a network, the method comprising:

obtaining a plurality of demands T, each demand T_i having diversity requirements D_i;

processing each demand T_i consecutively using a shortest path routing method to obtain a corresponding initial route R_i considering the diversity requirements D_i; and

re-processing demands T using a constrained diverse shortest path method to obtain corresponding final routes R' until a stop criterion is satisfied.